

Coastal Engineering Technical Note

SPACING REINFORCEMENT IN ARMOR UNITS

PURPOSE: To present two methods of spacing reinforcing bars during the construction of armor units. This is not a recommendation for either method but only information for field offices' consideration.

BACKGROUND: Rubble mound breakwaters are used extensively throughout the world to provide protection from the destructive forces of storm waves. In some locations, adequate size and quality quarrystone is not available, so specially shaped concrete armor units are required for the primary cover layer of the breakwater. Even when quarrystone is available, the concrete units may be the least costly alternative. The major advantage of these shaped concrete armor units is their high stability coefficient which permits the use of lighter weight armor units. Many different types of blocks have been developed, varying in geometric shape from simple rectangular or cubic blocks to more complicated shapes such as the "dolos" (dolosse is plural). See Figure 1. This unit was developed by Eric M. Merrifield of South Africa but it is free of patents restricting its use. The dolos also has a relatively high stability coefficient. Dolosse were used on the Manasquan Inlet Jetty Project (in New Jersey) which was completed in 1982. The contractor, providing dolos armor units for this project, developed a spacer which was very successful in reducing production time while



Figure 1. 40-Ton Dolosse in Place

maintaining the desired spacing of reinforcing bars in the 16-ton armor units.

Another method, which will also be discussed, has been successfully used for positioning reinforcing bars in 20- and 30-ton dolosse used at Kahului Harbor, Hawaii, in 1977.

DIMENSIONS OF DOLOS: Figure 2 and Table 1 give the dimensions and reinforcing bar spacing used by the Pacific Ocean Division and the Philadelphia District. These dimensions and spacings are examples of practices followed in specific designs. The decision to use or not use reinforcing as well as the design of the units and the amount of reinforcement must be made on a case by case basis.

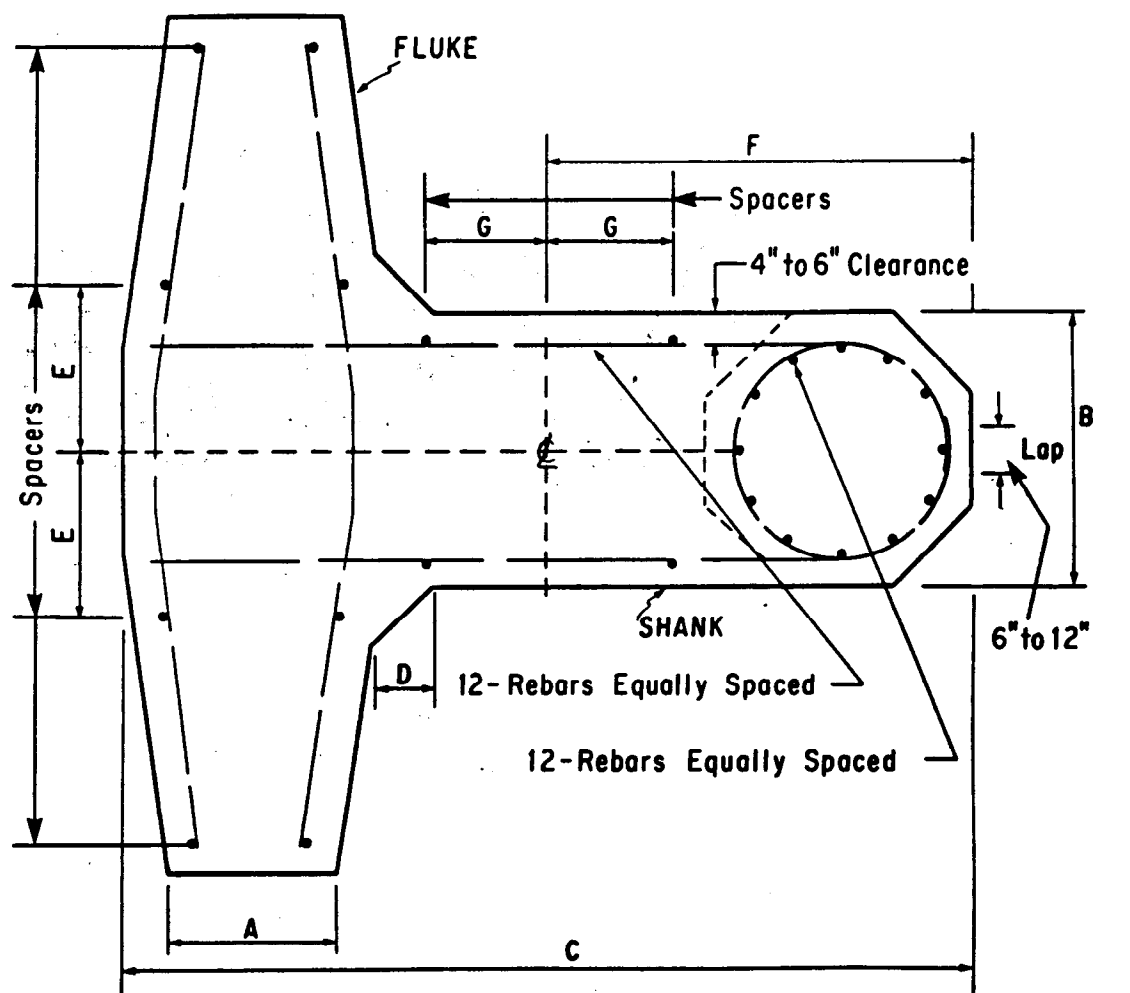


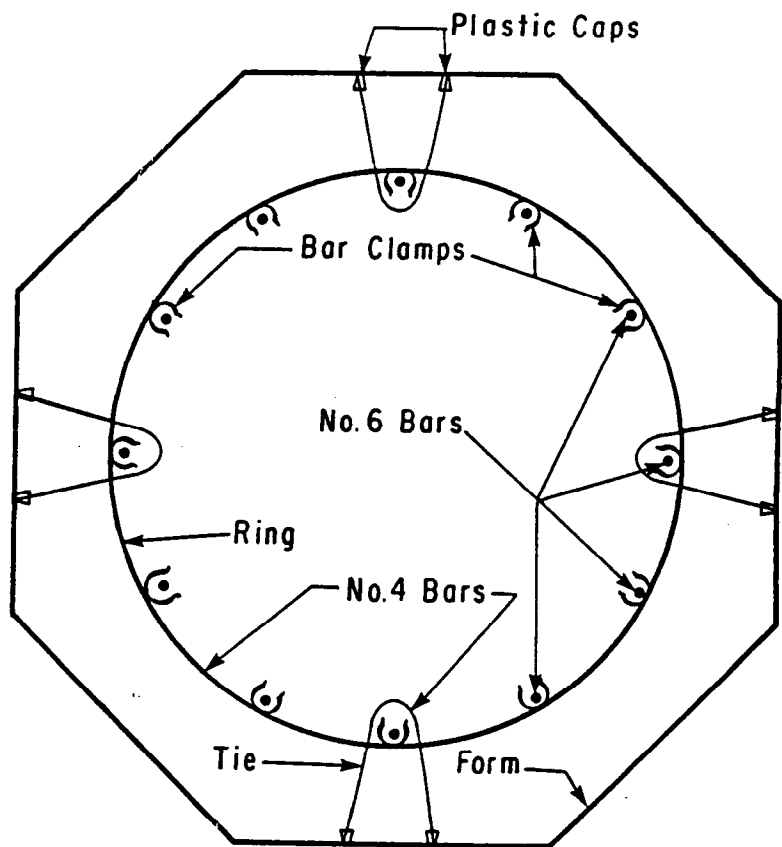
Figure 2. Reinforcing Steel for Dolosse

Table 1. Dimentions and Steel Schedule
for Different Size Dolos

SYMBOL	20-TON	30-TON	16-TON
A	2.39'	2.72'	2.20'
B	3.82'	4.36'	3.30'
C	11.94'	13.61'	11.04'
D	0.68'	0.78'	0.62'
E	2.41'	2.68'	2.23'
F	5.97'	6.81'	5.52'
G	1.65'	1.95'	1.53'
a BAR	#5	#6	#6
b BAR	#5	#6	#6

SPACER USED AT MANASQUAN:

The diagram in Figure 3 shows the functional parts of the spacer system which is composed of a circumferential ring, ties, and bar clamps. Twelve clamps, made from steel-gage sheet metal with spring action, are shop-welded to the inside of the ring, which is a No. 4 bar. The main reinforcing bars (in this case No. 6 bars) are then forced into the clamps which hold them in proper position. The ring is held in place, away from

Figure 3. Spacer for Reinforcing Bars
in Dolosse (Not to Scale)

the form, with prefabricated No. 4 bar ties which are welded to the ring after the rebars have been assembled. The assembling of the rebars and spacers is done on a "jig", outside the form, and the whole assembly is lifted and placed into the form at one time. The concrete is then added.

The spacer is made in two sizes since the dolos fluke sections are not uniform. Four spacers are used for each of the two flukes and two spacers are used for the shank section of the 16-ton dolos. The number of spacers varies with the size of dolos.

METHOD USED IN HAWAII: The following method was used for positioning reinforcing bars in the 20- and 30-ton dolosse at Kahului Harbor in 1977:

(1) Small precast concrete blocks 6 inches thick were placed under the rebars in the vertical fluke.

(2) Using 1/32" steel wire extending through holes in the forms, the reinforcing bars were held in position during pouring.

(3) After the pour, prior to settling of concrete, the wires were clipped flush with the form and the wire ends were pushed about 4 inches into the concrete. This method appears to have provided a good end product.

(4) Similar procedures to that used for dolos have been used for placement of rebars in tribars, except precast concrete pieces have been placed under the steel in each bar of the tribar.

ADDITIONAL INFORMATION: For details on the spacer used at Manasquan, contact Anthony Mele of Philadelphia District (215) 597-4753, and for further information on the Hawaii method of positioning rebars in armor units, contact Howard Kohayashi of the Pacific Ocean Division (808) 438-2837.